IRRIGATION VERSUS ECOSYSTEMS: WHAT ARE THE CHOICES?

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Abstract

The recently compiled Comprehensive Assessment of Water Management in Agriculture and the 2005 Millennium Ecosystem Assessment both foreshadow, over the next 50 years, increasing use of water for food and fibre, with resultant degradation of valuable rivers and wetlands. These are likely to occur in Australia as well as on a global scale.

This paper discusses some issues that need to be considered if we are to make better use of our wetlands for the long-term and to balance our water uses.

Introduction

Developing and managing water resources to help end poverty and hunger and feed an additional 2 billion people, while reversing ecosystem degradation, presents a significant global challenge, as outlined in the recently compiled Comprehensive Assessment of Water Management in Agriculture. The dilemma is that more people will require more water for agriculture, yet the way in which people use water in agriculture is globally the most important driver of ecosystem degradation. This is especially so for wetlands that provide many valuable ecosystem services for people.

The Millennium Ecosystem Assessment reported in 2005 that the expansion of agriculture and water regulation were the key drivers of ecosystem degradation globally, threatening the resource base upon which many people depended. The Assessment further showed that rivers and wetlands have borne the brunt of degradation; this is very evident in Australia with river regulation and water abstraction along with vegetation clearing and infilling of wetlands having inexorably changed the landscape. Given the extent of ecosystem degradation and water regulation globally it is feared that the equation for future food and water supply and demand globally may not add up. More water is required for poverty alleviation, for food production, for cities and industries, yet more water regulation threatens the provision of the ecosystem services that directly and indirectly underpin the livelihoods and well-being of many people.

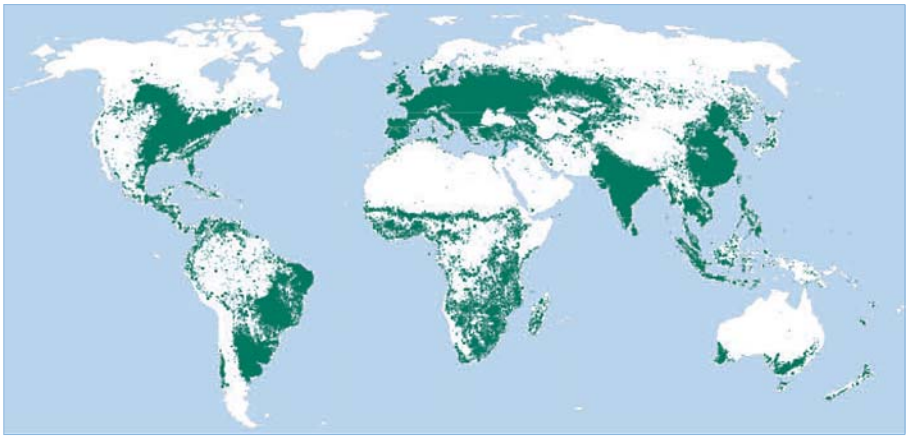

Figure 1. Cultivated systems (areas in which at least 30% of the landscape is cultivated) in 2000 (derived from the Millennium Ecosystem Assessment).

The scenarios are complex, for example, we know that globally many fisheries have been degraded through the regulation of rivers in order to obtain water supply for energy and irrigation and for urban use, and yet we still regulate rivers and divert water from valuable fisheries. There are vociferous arguments when it is realised that within many river basins there simply is not enough water – it has been allocated, or even over allocated. This scenario occurs in many countries; it is well known in Australia where drought exacerbates community debate over water management.

The Comprehensive and Millennium Ecosystem Assessments both recommended changes in the way we do business. Yesterday's approaches in support of agriculture and water regulation have not been fully effective in reducing poverty; instead they have led to a new set of issues - increased competition, environmental degradation, and water scarcity. New approaches are required to solve today's water and food production problems. These may not be that elusive.

Global Assessment of Ecosystems

The key messages developed by the Millennium Ecosystem Assessment are outlined below before considering the challenges people face in making decisions about investing in water for food, ecosystems and livelihoods.

i) Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre and fuel.

ii) The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but have been achieved at growing costs in the form of the degradation of many ecosystem services …… and the exacerbation of poverty for some groups of people.

iii) The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals.

Ecosystems globally have been transformed as a consequence of changes in land cover and land use (Figure 1). These changes have resulted in substantial gains in human well-being through the production of food, but there are increasing questions about whether or not this is sustainable given the loss of ecosystem services, including fisheries and others such as the regulation of erosion, floods and local climates. This is very apparent when considering wetland ecosystems – the situation is well known to Australia's irrigators who have witnessed salinisation and water logging associated with broad-scale changes in the landscape as water flows have been transformed and the native vegetation cleared. The imperative has been to produce food for

both local consumption and export – the question is not whether we need more food, it is whether or not the real costs are being counted; have we gone too far and how can we do things differently?

The Comprehensive Assessment has attempted to answer such questions within the context of achieving the UN-established Millennium Development Goals (Table 1).

Agricultural Demand for Water and Pressures on Wetlands

The push for greater agricultural production has resulted in more land being converted from natural to cultivated systems that now cover one quarter of the Earth's terrestrial surface (Figure 1). At the same time in order to provide water for cultivated systems, natural water regimes have also been altered. In response to increasing demands for water, large numbers of reservoirs have been constructed (Figure 2); the number of large dams in the world increased from 5000 in 1950 to more than 45,000 at present. Reservoirs now store water for 30-40% of irrigated land and generate 19% of global electricity supplies. Regulation of the water regime to this extent has caused significant degradation of wetlands/rivers, both inland and coastal. Dams have resulted in the fragmentation and modification of aquatic habitats, disrupting water flows, altering the flow of matter and energy, and establishing barriers to migratory species. An assessment of 227 major river basins globally showed 37% were strongly affected by fragmentation/altered flows, 23% moderately, and 40% unaffected.

In many instances the trend for further land conversion and water regulation and/or increased food production continues, as shown by the trend for irrigated areas in developing countries and globally (Figure 3). Projected increases in water withdrawals for irrigation for 2025 range from 4-24% with the lower value being due to optimistic projections about increases in rain-fed areas and an assumption that increased food trade will play a major role in overcoming demands for more food globally. Producing more food also means using more water, and on past trends, continued environmental degradation of wetlands through further conversion and/or water regulation!

The amount of water used for producing a range of food products has been calculated by various authors and despite some variability in the figures each person is held responsible for converting 2000-5000 litres of liquid water to vapour each day, compared to 2-5 litres for drinking and 50-200 litres for other household tasks. These

Table 1. Water management in agriculture and the Millennium Development Goals (From the Comprehensive Assessment of Water Management in Agriculture).

Millennium Development Goal	Role of water management in agriculture
Goal 1 Eradicate extreme poverty and hunger	Increase agricultural production and productivity to keep up with rising demand and maintain affordable food prices for the poor; improve access to factors of production and markets for the rural poor.
Goal 3 Promote gender equality and empower women	Enhance equitable access to water and thus the ability to produce food.
Goal 4 Reduce child mortality Goal 5 Improve maternal health Goal 6 Combat HIV/AIDS, malaria and other diseases	Contribute to better hygiene and diets, particularly through the appropriate use of marginal-quality water and the integration of multiple water-use approaches into new and existing agricultural water management systems, including domestic and productive functions.
Goal 7 Ensure environmental sustainability	Integrate the principles of sustainable development into agricultural water development to reverse the loss of environmental resources.
Goal 8 Develop a global partnership	Involve the diverse range of practitioners, researchers, and for development decisionmakers in the preparation of water management actions.

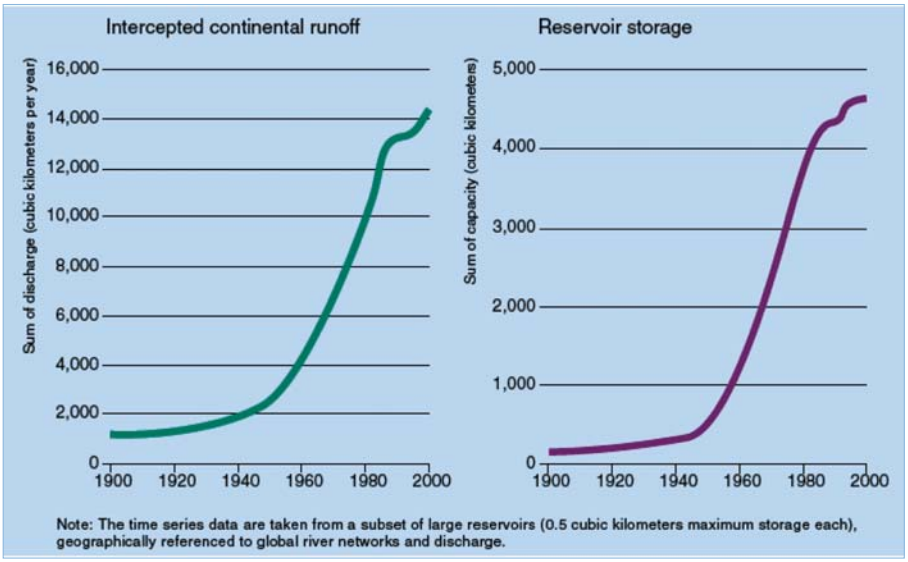

Figure 2. Intercepted continental runoff and reservoir storage (derived from the Millennium Ecosystem Assessment).

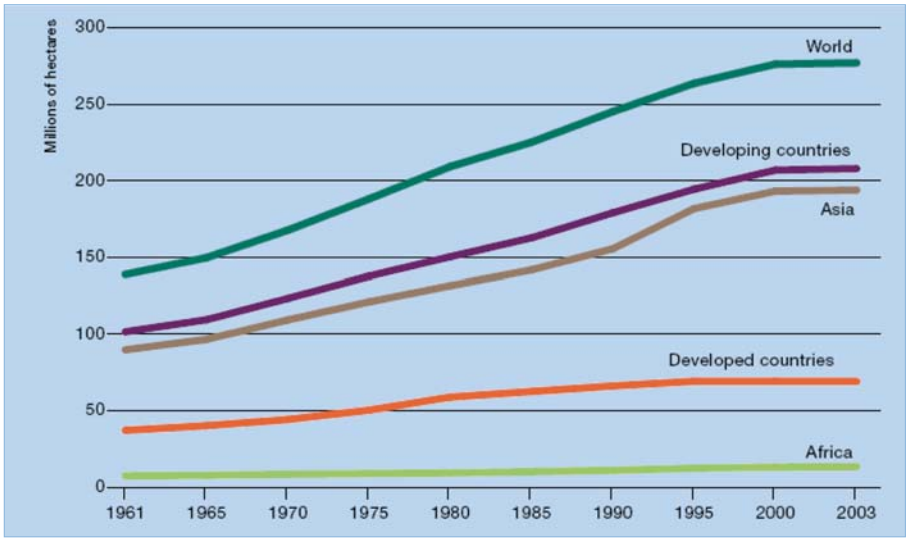

Figure 3. Global irrigated areas (derived from information supplied by FAO and presented in the Comprehensive Assessment of Water Management in Agriculture).

figures illustrate the importance of food production in the water cycle. As consumption patterns continue to change, with, for example, increased demand for higher water-demanding grain-fed meat products, the demand for water will intensify.

Over the next 50 years the demand for food crops is projected to grow and food production to intensify. Demand for water will therefore inevitably increase, with water withdrawals in developing countries increasing significantly and those in industrial countries declining. Many countries or basins are expected to suffer water scarcity, whether from physical or economic constraints (Figure 4). Substantial increases in the efficiency of water use and management may lessen the future demand for water, although achieving efficiencies may be made more complex by the consequences of global climate change.

Further development of irrigation may also result in further physical scarcity of water in many basins (Figure 5), even if economic scarcity declined. Under the scenario shown in Figure 5 some 2.6 billion people may be living in water scarce basins by the year 2050. Scenarios involving large increases in irrigation also highlight the need for more dams and increases in water withdrawals by some 50-60% with potential large impacts on rivers and wetlands and alterations in the timing and variability of flows. Scenarios involving increased productivity of rain-fed agriculture could reduce such impacts, but further diversion of rainfall and runoff from aquatic ecosystems is expected to exacerbate the impacts caused by dams and river regulation. The issue of intercepting and storing large volumes of off-channel water is already contentious in Australia.

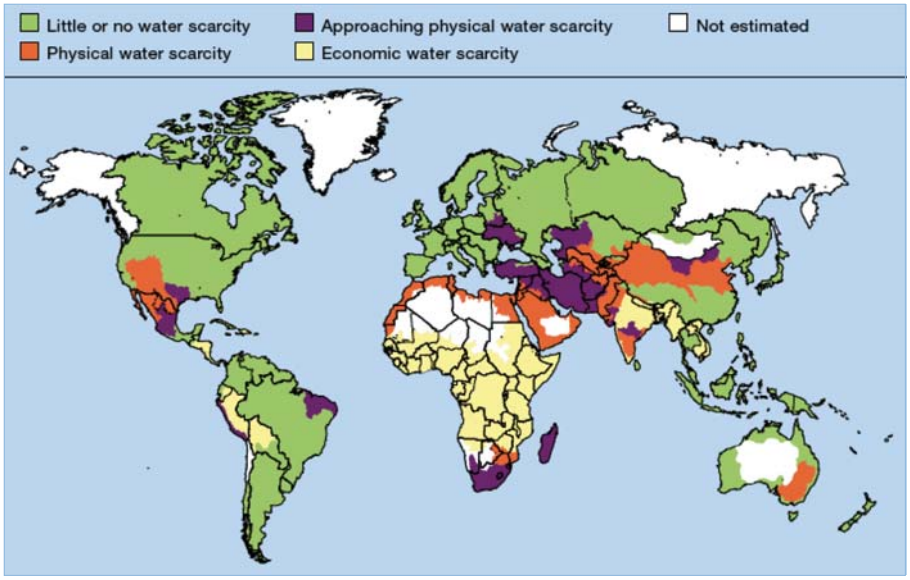

Figure 4. Areas of physical and economic water scarcity (from the Comprehensive Assessment of Water Management in Agriculture).

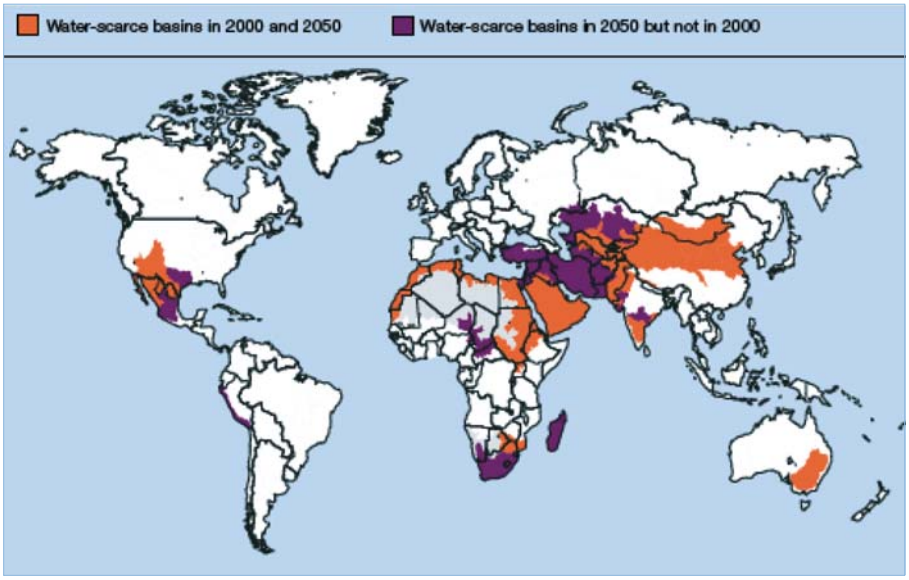

Figure 5. Water scarce basins in 2000 and 2050 (from the Comprehensive Assessment of Water Management in Agriculture).

Wetlands – Extent and Change

Estimates of the global extent of wetlands differ significantly and are highly dependent on the definition of wetlands and on the methods used for delineating them. The estimated extent of wetlands globally derived from national inventories is approximately 1,280 million hectares, which is considerably higher than previous estimates. Nevertheless, this figure is considered an underestimate, especially for southern America and for certain wetland types (such as intermittently flooded inland wetlands, peatlands and artificial wetlands) where data were incomplete or not readily accessible. The estimate for Australia of 24 million hectares (<2% of the global total) is based on an incomplete and inconsistent information source.

The extent of wetland loss and degradation is widely recognised, but not often supported by quantitative data. More than 50% of specific types of wetlands in parts of North America, Europe, Australia, and New Zealand were lost during the twentieth century, but extrapolation of this estimate to wider geographic areas or to other wetland types is fraught with inaccuracy. There is insufficient information available on the extent of all wetland types to document the extent of wetland loss globally. Much of the loss that has been recorded occurred in the northern temperate zone during the first half of the twentieth century, whereas many tropical and sub-tropical wetlands, such as swamp forests, were lost or degraded over the second half of the century.

Clearing and drainage, often for agricultural expansion, and increased withdrawal of freshwater are the main reasons for the loss and degradation of inland wetlands such as swamps, marshes, rivers, and associated floodplain water bodies. By 1985, an estimated 56-65% of inland and coastal marshes (including small lakes and ponds) had been drained for intensive agriculture in Europe and North America and 27% in Asia. Agricultural systems and practices have exerted a wide range of mostly adverse impacts on inland and coastal wetlands globally. Both the extensive use of water for irrigation and excessive nutrient loading associated with the use of nitrogen and phosphorus in fertilisers have resulted in a decline in the delivery of services such as freshwater and

some fish species. The introduction of invasive alien species is now considered to be a major cause of extinction of native freshwater species.

There is also evidence of a rapid and continuing widespread decline in many populations of wetland-dependent species, including mollusks, amphibians, fish, waterbirds, and some mammals. An index of the trend in vertebrate species populations shows a continuous and rapid decline of 50% in freshwater vertebrate populations between 1970 and 2000 – more drastic than that for terrestrial or marine species (Figure 6). Even in the case of more poorly known wetland fauna, such as invertebrates, assessments show that species in these groups are significantly threatened with extinction. A summary of information on the status of wetland species is shown in Table 2.

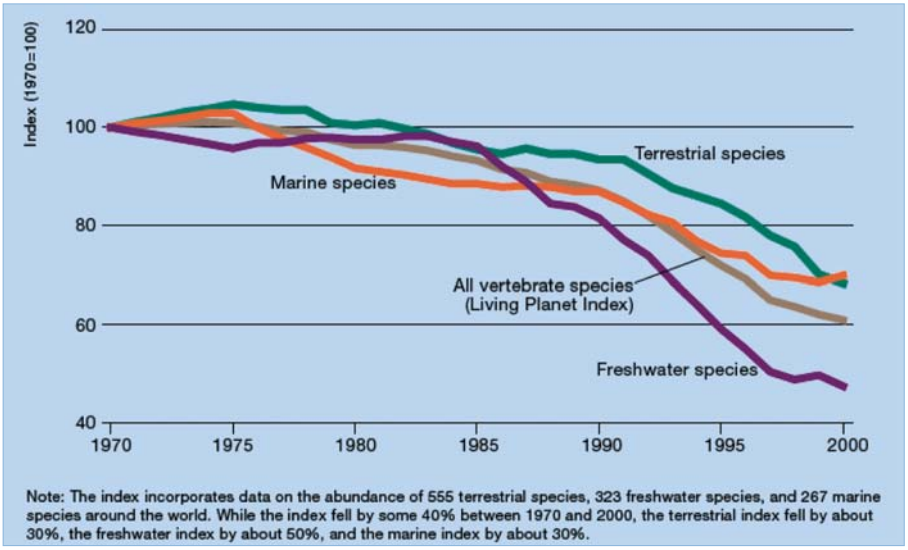

Figure 6. The Living Planet Index (from the Millennium Ecosystem Assessment based on information from WWF and UNEP-WCMC).

The Future – Concluding Comments

In concluding, a few key statements are presented as a basis for further analysis and consideration when discussing management responses. These introduce some issues that need to be considered if we are to make better use of our wetlands for the long-term and to balance our water uses:

- Increased pressure from increased population and consumption of food will translate to increased pressure on wetlands and further loss of wetland species and ecosystem services –can we afford to lose further wetlands and their ecosystem services, many of which are provided without cost to society as a whole?
- Business as usual will result in more competition between food production and nature and result in more environmental degradation, and possible persistence of poverty and food insecurity – the manner in which we do business needs to be reassessed and placed within the context of reducing poverty and ensuring sustainable agriculture;
- Improving irrigation efficiency may make gains for food production, but may not enhance the surrounding environment as in many basins little water is being wasted - leakages from irrigation systems can be captured, but with likely adverse affects on groundwater recharges or flows that currently occur back to wetlands;
- Improving productivity through improved crop yields through irrigation may result in increased use of fertilisers and agricultural chemicals and increased pollution and eutrophication of many types of wetlands – the balance between intensification and extensification of agriculture still needs to be explored as it may not be a panacea for better environmental outcomes;
- Increases in water productivity and upgrading of rain-fed food production hold a lot of promise for increasing food production and could occur given better governance, policies and institutions – the social dimension for ensuring sustainability and poverty reduction cannot be underestimated.

As a final comment, the following is proffered. Can we achieve sustainable development of wetlands – can we put our concepts into practice and develop wetland resources and conserve them at the same time? Is it possible to develop wetlands without further running down the resource and the very processes and interactions that support the wetland? An integrated approach is needed for managing land, water, and ecosystems.

Much of the discussion above relates to a global scenario of increased pressure on water resources and balancing societal outcomes. Australia is not immune to this pressure – we face them when making choices about the allocation of our water as demand from urban uses increases and climate variability and drought imposes more stress on our water resources and infrastructure. As a major food exporting country our choices will have international ramifications and will be influenced by international conditions.

Table 2. Condition of wetland vertebrates globally (derived from the Millennium Ecosystem Assessment).

Vertebrate group	Condition
Waterbirds	20% extinct or threatened
Mammals	30% in decline (especially dolphins, porpoises ...)
Fish (freshwater)	20% threatened or extinct
Amphibians	30% threatened (not all are aquatic)
Turtles	50% threatened
Crocodiles	45% threatened

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